SEISMIC SAFETY ELEMENT

AN ELEMENT OF THE GENERAL PLAN

CITY OF ESCONDIDO

OCTOBER 1975

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EXHIBITS

RESOLUTION NO. 75-226

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF ESCONDIDO, CALIFORNIA, ADOPTING A SEISMIC SAFETY ELEMENT OF THE GENERAL PLAN OF THE CITY OF ESCONDIDO.

WHEREAS, the Planning Commission of the City of Escondido has, by Planning Commission Resolution No. 2743, approved a Seismic Safety Element of the General Plan after holding duly noticed public hearings thereon; and

WHEREAS, this City Council has held a public hearing after due and legal notice thereof as required by law; and

WHEREAS, this City Council is desirous at this time and deems it to be in the best public interest to so approve said Seismic Safety Element;

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Escondido, California, as follows:

1. That the above recitations are true and correct.

2. That, upon due consideration of all the evidence submitted, said Seismic Safety Element of the General Plan of the City of Escondido is hereby adopted.

PASSED, ADOPTED AND APPROVED by the City Council of the City of Escondido, California, at a regular meeting thereof this 15th day of October, 1975.

AYES : Councilmen: Boyce, Harmon, Linthicum, Roberts, Skuba

NOES : Councilmen: None

ABSENT: Councilmen: None

APPROVED:

Lorraine H. Boyce

LORRAINE H. BOYCE, Mayor
City of Escondido, California

ATTEST:

Rachel C. Evans, Deputy

LINA M. HILL, City Clerk
City of Escondido, California

RESOLUTION NO. 2743

RESOLUTION OF THE PLANNING COMMISSION OF THE CITY OF ESCONDIDO RECOMMENDING THE ADOPTION OF THE SEISMIC SAFETY ELEMENT, AN ELEMENT OF THE GENERAL PLAN, IN THE CITY OF ESCONDIDO, COUNTY OF SAN DIEGO, STATE OF CALIFORNIA.

WHEREAS, on August 26, 1975, the Planning Commission did hold a public hearing to consider recommending to the City Council the adoption of the Seismic Safety Element, an Element of the General Plan, in the City of Escondido; and

WHEREAS, a notice of hearing to consider the adoption of the Seismic Safety Element, an Element of the General Plan, pursuant to the provisions of Section 65302.1, Article 5 of the Government Code, was published in the Times Advocate, a newspaper of general circulation published in the City of Escondido, and the Affidavit of Publication is on file in the records of the Planning Commission; and

WHEREAS, the Planning Commission has completed studies for the Seismic Safety plan within and around the City of Escondido as prepared by the Planning Department; and

WHEREAS, the State of California has enacted the Planning and Zoning Law which provides for the adoption of general plans and separate elements; and

WHEREAS, after notice given as required by law, one Public Hearing was held on August 26, 1975 to consider the adoption of the "Seismic Safety Element" an element of the General Plan, and said hearing was continued to September 23, 1975.

NOW THEREFORE, BE IT RESOLVED by the Planning Commission of the City of Escondido that it hereby adopts and recommends for approval to the City Council the "Seismic Safety Element, an Element of the General Plan."

PASSED, ADOPTED AND APPROVED by a majority vote of the Planning Commission of the City of Escondido, at a regular adjourned meeting held on the 23rd day of September, 1975, by the following vote, to wit:

RESOLUTION OF THE PLANNING COMMISSION OF THE CITY OF [illegible]
[illegible] THE [illegible]
[illegible] ELEMENT, AN ELEMENT OF THE [illegible]
THE CITY OF CUPERTINO, COUNTY OF [illegible] STATE OF
CALIFORNIA

WHEREAS, on January [illegible], 1975, the Planning Commission [illegible] public hearing to [illegible] the City Council the adoption of the Seismic Safety Element, an Element of the General Plan, to the City of Cupertino; and

WHEREAS, a notice of hearing to consider the adoption of the Seismic Safety Element, [illegible] pursuant to the provisions of Section [illegible] of the Government Code, was published in the [illegible], a newspaper of general circulation published in the City of Cupertino, and the affidavit of such publication is on file in the records of the Planning Commission; and

WHEREAS, the Planning Commission has [illegible] for the Seismic Safety [illegible] the City of Cupertino as [illegible] by the Planning Commission; and

WHEREAS, the Planning Commission [illegible] and [illegible] the [illegible] Elements; and

WHEREAS, [illegible] the "Seismic Safety Element" [illegible] was [illegible] September 23, 1975.

NOW THEREFORE, BE IT RESOLVED that the Planning Commission of the City of Cupertino [illegible] the City Council the "Seismic Safety Element" [illegible]

PASSED, APPROVED AND ADOPTED [illegible] Commission of the City of Cupertino, [illegible] the third day of September, 1975, by the following vote:

AYES: Commissioners Pfeiler, Cate, Smith, DeJong

Mahan, & Vessels

NOES: None

J. Webb Cate Jr.

J. WEBB CATE, JR., Chairman
Escondido Planning Commission

ATTEST:

Darrell Daugherty

DARRELL DAUGHERTY, Secretary
Escondido Planning Commission

I hereby certify that the foregoing Resolution was passed at the time and by the vote above stated.

Kathryn Rupp

Clerk of the Planning Commission

INTRODUCTION

The Seismic Safety Element has been designed to identify and evaluate seismic hazards within the Escondido planning area, and to propose methods to mitigate the effects of such hazards where possible or practical, in conformance with the requirements of State Law and in recognition of the City's responsibility to its citizens.

As the first step in this process, this report indicates that additional information is needed in certain areas to more fully evaluate potential hazards such as slide-prone areas, water table depths, depth and nature of alluvial soils, and dam safety. In this regard, the report fulfills its initial function of identifying potential hazards, and creates an awareness of the need for additional information for planning purposes.

The information that is known, as well as historical records, indicates Escondido is remarkably free from seismic hazards despite relatively high quake activity along fault systems outside of but near the planning area. Despite records which indicate little or no local damage from such acitvity, the report indicates a potential for damage exists, since no major seismic event has been recorded as close to the planning area as could potentially occur.

It is expected that, as the mechanisms for collecting additional data are implemented and new information and knowledge is gained, this element will be amended and expanded to further increase its usefulness for planning purposes.

PURPOSE

The purpose of this study is to review the potential for seismically related hazards and to develop specific seismic safety planning policies for the City of Escondido Planning Area. As stated in the "State guidelines for the Preparation of a Seismic Safety Element":

> "The Seismic Safety Element was proposed as a simple first step in directing a community's attention to a primary means of limiting future earthquake losses. The most obvious and least expensive way to achieve this goal is through the adoption of rational land-use policies."

Through reviewing potential seismic hazards and relating them to land use planning policy, it is hoped that seismic risk can be reduced.

This report will review the physical conditions and seismic history of the region in which Escondido is located. It will consider the activity and recurrence rates for major regional faults. It defines acceptable levels of risk and presents an evaluation of potential seismic risks. Policies are proposed to update this study and reduce future potential hazard to life and property.

RESPONSIBILITY, AUTHORITY

It is the responsibility of the City as a representative of the people to provide for a safe environment for its citizenry. The City should identify potentially hazardous areas, provide guidance for safe development techniques, investigate existing structural hazards and pass legislation to provide for the overall safety of its citizens and visitors.

The State Planning and Zoning Law, Government Code Section 65302, now requires each city and county within the State of California to prepare and adopt a Seismic Safety Element as a part of its General Plan. The statutory provisions read:

> "65302. The General Plan shall consist of a statement of development policies and shall include a diagram or diagrams and text seting forth objectives, principles, standards and plan proposals. The plan shall include the following elements:
>
> "(f) A seismic safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to effects of seismically induced waves such as tsunamis and seiches.
>
> The seismic safety element shall also include an appraisal of mudslides, landslides, and slope stability as necessary geologic hazards that must be considered simultaneously with other hazards such as possible surface ruptures from faulting, ground shaking, ground failure and seismically induced waves."

FINDINGS

This section is intended to evaluate potential conditions and damage resulting from future seismic event. State legislation requires this document to identify and appraise seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failure, and the effects of seismically-induced waves. This evaluation is based on the regional seismic history, established reccurance rates for major faults, and local physical constraints. Distance from an earthquake epicenter, characteristics of soil or rock, depth of focus of an earthquake, and duration of ground shaking are all important factors influencing the extent of damage from a given earthquake. However, given a moderate-to-great earthquake (over 6.0 Richter magnitude), the most important factors affecting damage to property and loss of life are density of development and type of building construction.

For Escondido the findings are:

1. There are no known active faults or major landslide areas within the Escondido Planning Area.
2. The highest danger during a seismic event would be structural failure caused by ground shaking.
3. There is no apparent potential for liquefaction in the Escondido Planning area.
4. There may be minor potential for small localized landslides in steep areas.
5. Generally stable local conditions and the lack of local active faults indicate there is almost no potential for surface rupture, cracking and fissuring, compaction, subsidence, or uplift.
6. Potential for damage to and from structures has been reduced by the implementation of the unsafe structure ordinance (Ordinance 1147).
7. Potential for dam failure or overtopping due to seismic events or landslide activity is being analysed and should be completed by early 1976.
8. Despite historic evidence of little or no local damage from seismic events originating outside of the Planning Area, some potential for damage may exist since such past events have not been of the maximum intensity or magnitude that may occur and have not been epicentered as close to the Planning Area as could potentially occur.

RECOMMENDATIONS

Based on the findings of the Seismic Safety Study, the following policies and programs are recommended to reduce the hazards associated with seismic activity within the Escondido Planning Area.

* A survey to be conducted by the Building Department to identify these structures which were built prior to Building Code adoption, to evaluate the risks posed by such structures, and to recommend methods to abate any hazards so identified.
* Adoption of revisions or amendments to the Uniform Building Code related to seismic safety when promulgated. The City shall also encourage continued research on seismic reaction in buildings.
* Cooperation with San Diego County in forming and maintaining a "Geologic Data Bank" for maintaining data and research on seismic and geologic data.
* Include and keep current earthquake disaster planning as part of the Emergency Plan, City of Escondido.
* Require Soil and Geology reports on all high rise, emergency and essential buildings, high occupancy buildings and developments on slopes over 15% or wherever geologic problems are suspected.
* Where conditions warrant, the City Engineering Department shall require studies on seismic and geologic hazards as part of Environmental Impact Reports (EIR)
* Seek funds for geologic studies intended to map the geologic-base and soil depths, water table depths, and identify any presently unknown faults, or hazardous conditions.
* Evaluate and amend this element as new findings and information becomes available.

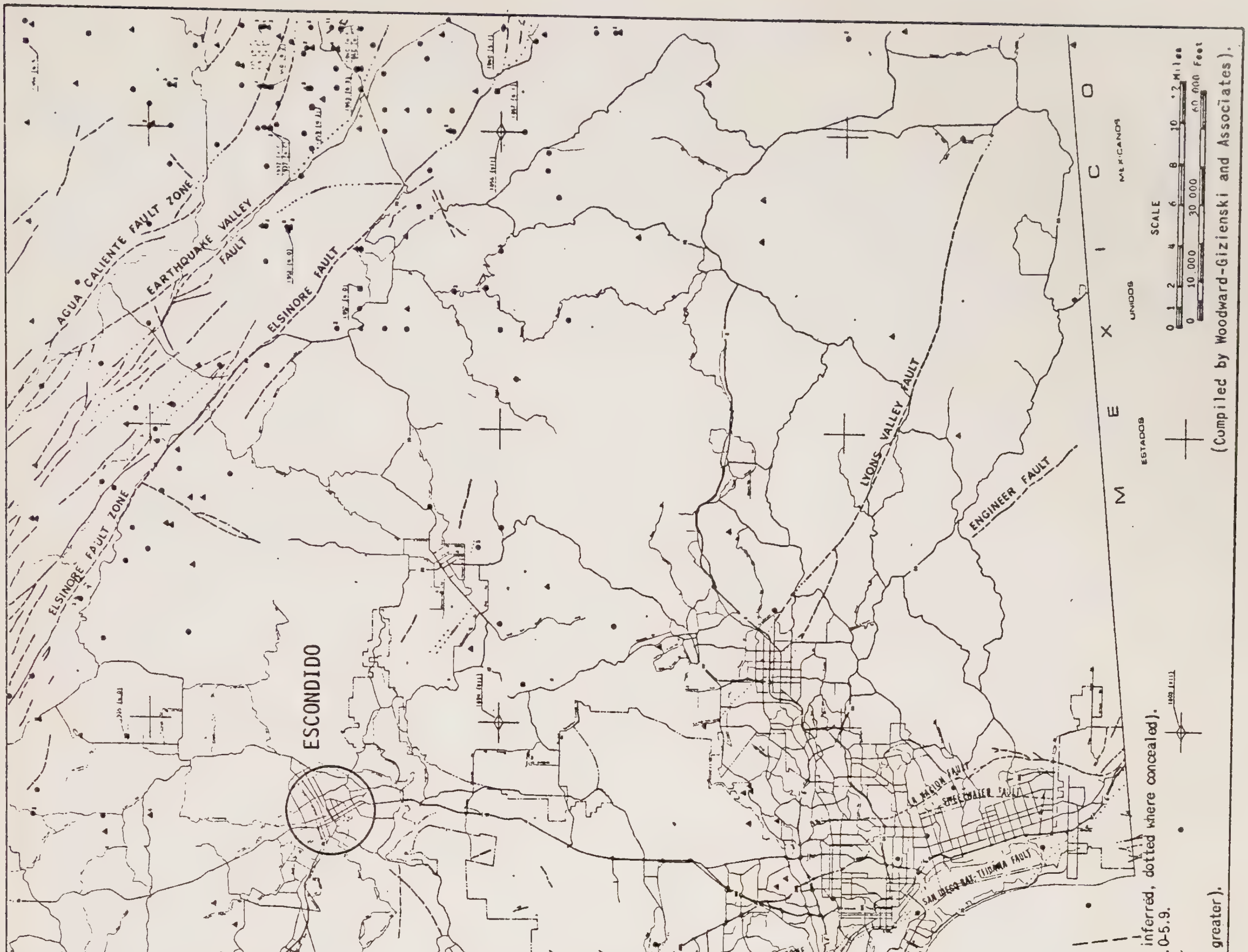
SITE AND SITUATION

Escondido is located in an alluvial valley surrounded by the granitic foothills of the Southern California Peninsular range. This is part of the seismically-active East Pacific fracture zone, a part of the so-called Circum-Pacific Ring of Fire. The peninsular range is bisected and surrounded by a number of major active and inactive faults. Remarkably, Escondido is almost completely free of fault activity. There are no faults located within the City boundaries, and only two inferred faults enter the Planning Area for a short distance near the Del Dios area. Although this indicates that there is little chance of seismic events originating or being centered within Escondido, hazards from surrounding faults must be considered.

In the region surrounding Escondido there are a number of major northwest-trending faults. The closest of these are the Elsinore and Rose Canyon faults, 16 to 20 miles from Escondido. Other important faults include the San Jacinto fault (42 miles from Escondido), and the San Andreas fault, approximately 70 miles from Escondido).

These are the faults that, because of either length or activity levels, present the greatest threat of seismic hazard to Escondido. A discussion of the individual characteristics of these faults and the hazards they pose to Escondido follows. (Throughout this discussion and the remainder of this report, Arabic numbers will refer to Richter Scale magnitudes and Roman numerals will refer to Mercalli Scale Intensities. Likewise, the term "magnitude" will refer to the Richter Scale and the term "intensity" will refer to the Mercalli Scale. For a discussion of these two scales, see Appendix C.)

THE CIRCUM—PACIFIC SEISMIC BELT



MAP OF FAULTS AND EPICENTERS

Source:
Seismic Safety Study for the City of San Diego. Compiled by Woodward and Gizienski and Associates 1974.

ELSINORE FAULT

The Elsinore Fault is a large, active, northwest-trending fault which comes as close as 16 miles to Escondido. The overall length of the fault is approximately 135 miles; however the most active portion of the Elsinore Fault is the 60 mile section between Lake Elsinore and the Vallecito Valley. There have been a number of epicenters in the Lake Elsinore area. Because of its proximity and great length, the Elsinore Fault has the greatest potential to cause damage to Escondido. The maximum probable earthquake has been calculated at 6.9-7.3. The recurrance interval for an event of this magnitude has been estimated at one per hundred years.* The maximum credible earthquake is approximately 7.6 with no calculable recurrance rate.

The largest recorded quake on the Elsinore Fault occurred in 1910, was centered in the Lake Elsinore area, and was recorded as having a magnitude of 6. This event, epicentered about 40 miles from Escondido, caused no recorded damage in the Escondido area. A maximum probable quake of 6.9 to 7.3, with an epicenter located on the closest sections of the fault, might cause light to moderate damage to unreinforced or weakly built masonry structures and heavy damage or collapse in unreinforced masonry structures. A maximum credible quake of 7.6 could cause moderate to heavy damage to weak masonry structures and light to moderate damage in wooden frame structures.

Quakes with epicenters along the more distant sections of the fault are not likely to cause significant damage in the Escondido area.

The Agua Caliente Fault and the Earthquake Valley Fault are considered major branches of the Elsinore Fault. These faults are located approximately 25 and 28 miles respectively from Escondido and, although believed active, little is known about their recurrance rates or potential for damage.

* These figures are taken from the Woodward and Gizienski study for the Seismic Safety Element of the City of San Diego. While this study is considered the most recent and comprehensive, other sources have suggested a much longer recurrence interval of 750 to 1000 years for an event of magnitude 7. If correct, the risk from the Elsinor Fault would be greatly reduced.

The Temescal Fault runs roughly perpendicular to the Elsinore Fault and intersects it just west of Lake Henshaw. There have been many small (2.0 to 3.9 Mag.) epicenters located in this area. These may or may not represent the release of accumulated strain along the Elsinore Fault; however, the continual release of small amounts of energy along this fault reduces the potential of a major event occurring.

SAN JACINTO FAULT

The San Jacinto Fault is a major, active, northwest-trending fault which lies 42 miles from Escondido at its closest point. The San Jacinto Fault is considered to be a major active branch of the San Andreas Fault system. Land forms along the fault indicate a long active history. It's proximity (42 miles) and activity make it more significant to Escondido than the San Andreas itself, which at its closest point is about 70 miles from Escondido. Significant events occurring along the San Jacinto Fault include an intensity VI quake in 1890 and quakes of intensity IX in 1899, magnitude 6.5 in 1968 and 5.9 in 1969. There was no reported damage in the Escondido area resulting from the 1890 and 1899 events. The 1968 quake, considered the strongest to hit California in 15 years, caused only minor damage locally, limited to items falling off shelves, with no reports of broken pipes or structural damage. The 1969 quake tripped several burglar and fire alarms but caused no reported damage.

The maximum probable quake has been estimated at 6.9 to 7.3, with one such event occurring per 100 years. The maximum credible quake for the San Jacinto Fault is considered to be approximately 7.6 with no calculable recurrance rate. Damage resulting from a maximum probable intensity event would be expected to cause little or no damage in well built structures, light to moderate damage in poorly built structures, and possible heavy damage or collapse of unreinforced masonry structures. A maximum credible quake would be expected to cause similar but more widespread damage resulting from greater intensity and duration.

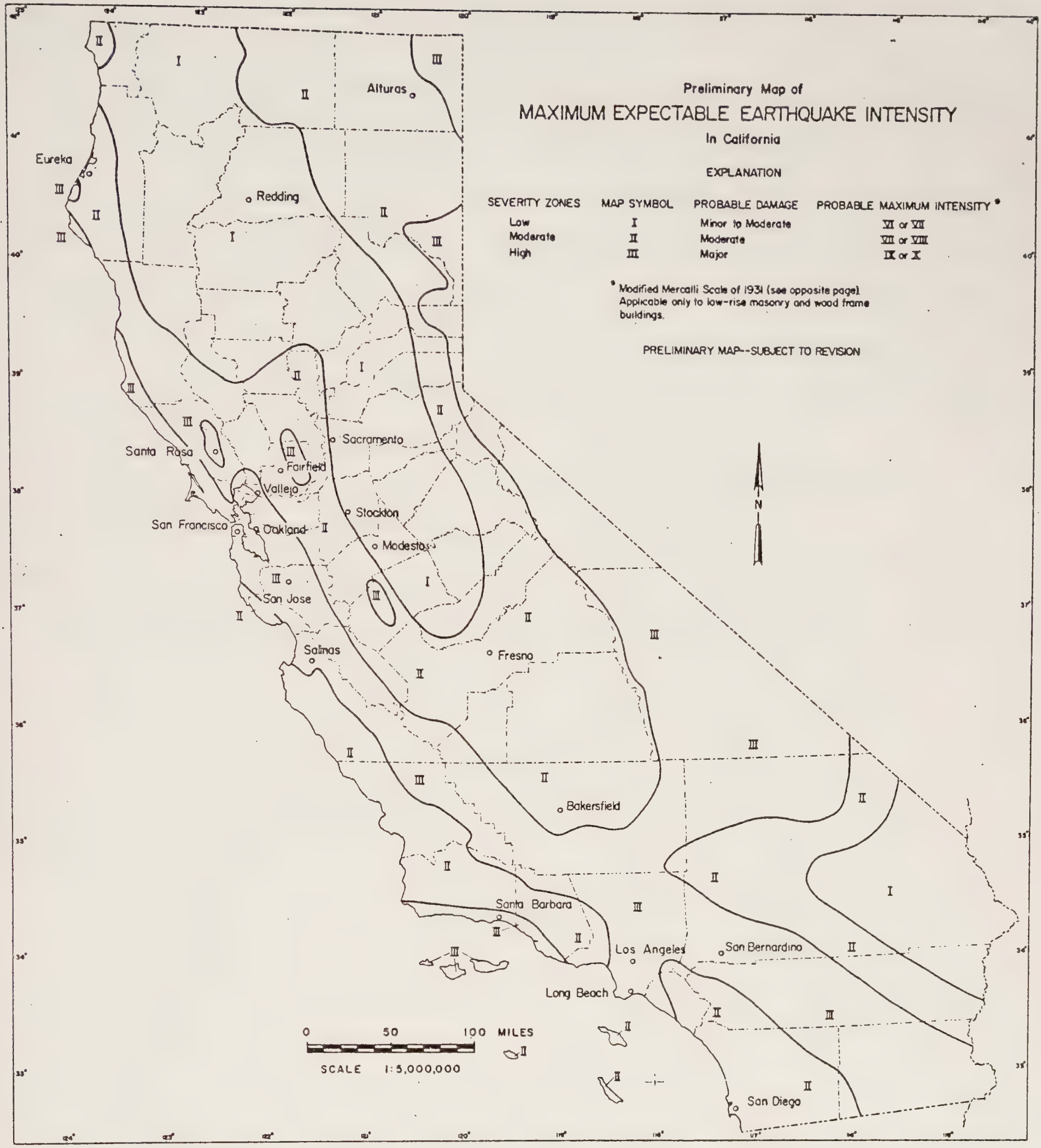
The San Jacinto fault is approximately twice as far from Escondido as the Elsinore fault. This distance has an insulating effect, and makes the San Jacinto Fault relatively less hazardous to the Escondido area than the Elsinore Fault.

The Coyote Canyon Fault is considered a branch of the San Jacinto Fault. During the 1968 magnitude 6.8 quake, a surface rupture 20.5 miles long occurred along this fault. No recurrance rates or probable earthquake intensities are available for this fault; for planning purposes it should be considered part of the San Jacinto Fault zone.

ROSE CANYON FAULT

The Rose Canyon Fault lies 16 to 20 miles west of Escondido in the Pacific Ocean, and may be part of the Newport-Inglewood Fault system which has been historically active and was the source of the 1933 Long Beach Earthquake. The Rose Canyon segment has not been active in the last 500,000 years, but its great length and epicenters near the fault indicate that it is potentially active. Epicenters of V and VI intensity have occurred near the Rose Canyon Fault. The Seismic Safety Study of the City of San Diego, by Woodward and Gizienski, indicates the maximum probable earthquake would be between 5.8 and 6.2 with two repeat intervals of one per 100 years. The maximum credible earthquake would be approximately 7.1 with no stated recurrance interval. There are no known reports of damage in Escondido resulting from epicenters near the Rose Canyon Fault.

A maximum probable quake on the closest section of the Rose Canyon Fault would be expected to cause only light damage in the Escondido area. Unreinforced masonry or poorly built structures might sustain moderate damage on the closest sections of the Rose Canyon Fault. A maximum credible earthquake could cause light to moderate damage in well built structures and heavy damage or collapse in poorly built structures.



Source:
California Division of Mines and Geology, Bulletin #198 1973.

LOCAL FAULTS

There are a number of small scale local faults in the area surrounding Escondido. These faults are short in length, and are capable of releasing relatively small amounts of energy. These faults, unless shown to be part of a larger system, should not be considered hazardous beyond the areas immediately adjacent to their traces. Two inferred fault traces enter the Escondido Planning Area near the Del Dios area. Both faults are approximately 4 miles long, and run west and south from the Lake Hodges-Del Dios area. There are no known historic epicenters located along these faults, and recurrance rates are unknown.

There are small faults located near Rancho Bernardo, Poway, and Romona. Some landslides have been associated with these faults but there are no epicenters greater than magnitude 3 located near these faults. Possible activity levels or recurrance rates are not known; however, they appear to present no hazard to Escondido.

SEISMIC HISTORY

A review of the seismic history of Escondido indicates that although it has been relatively close to a number of major earthquake epicenters, very low levels of damage were sustained. The most severe damage was an occasional damaged pipe or objects falling off shelves. There are no reports of structural failure, chimney failure, loss of life, or even injuries. This lack of damage may be due to lack of development during the early history of Escondido; however, major seismic events took place in 1956 and 1968 with only minor damage. From the review of the seismic history it appears that Escondido remains remarkably stable during seismic events. This is apparently related to distance from past epicenters and the relatively shallow bedrock foundation conditions in the Escondido area.

In February 1956 there were two major quakes with epicenters in Baja California. The first occurred on February 9 and registered 5.8. This quake damaged two water lines, shook homes and rattled windows. On February 14 another quake from the same area registered 6.5. There is no record of any damage from the second quake.

On April 9, 1968 an earthquake rated at 6.5 occurred at Borrego Mountain. No structural damage and only minor breakage from objects falling off shelves was reported.

TABLE I

Major Recorded Quakes, Effects on Escondido Where Known

DATE	LOCATION AND MAG. OR INTENSITY*	ESCONDIDO TIMES ADVOCATE COMMENTS
Feb 9, 1971	San Fernando Valley (Sylmar):6.5	No reports of Escondido damage, many awakened by jolt.
Mar 28, 1969	Borrego Springs: 5.9, V in San Diego	Tripped fire and burglar alarms, numerous calls, no damage.
Mar 8, 1968	6.5, VII-VI in San Diego frightened many, minor damage	Worst since 1952 Tehachapi quake. Some breakage from goods falling off shelves in markets, no damage to water lines or sewers.
Dec 22, 1964	5.5	"Worse in Decade" Felt L.A. to Mexican Border. Extensive property damage in S.D., none reported in Escondido.
Feb 14, 1956	6.5	Felt L.A. to Mexican Border. No damage in Escondido.
Feb 9, 1956	6.8, VI-VIII - Mexico to S. D.	Shook houses and windows. Two minor cracks -- in water lines.
Jan 3, 1956	4.7 - Mexico to S. D.	Shook houses and windows.
Jan 2, 1956	Centered off Calif. coast - no damage reported.	Woke residents, rattled windows and dishes.
Nov 12, 1954	6.3 - felt in S. D. & much of Southern California	Located in Baja. No damage in San Diego.
Oct 24, 1954	6.0 felt in San Diego	No damage, located in Baja.
Oct 17, 1954	5.7 felt in San Diego	No damage reported in S.D.; 250 miles off coast.
Nov 22, 1954	5.1, VI - Slight damage from Palm Springs to San Diego.	--------
Mar 19, 1954	VI at La Jolla - minor damage in La Jolla	Mag. 5 Centered N.E. of San Diego, no report in Escondido.
June 13, 1953	VII-felt in S.D. to Phoenix.	--------
Dec 25, 1951	5.9, VI - Slight damage in S.D., North parts of County.	Ocean Floor South of San Clemente Island. No damage. No local articles.
Sep 5, 1950	4.8, felt in San Diego.	Rocked Riverside, no report in Escondido.
Jan 1, 1946	3.3 - La Jolla, S.D. National City	Localized, not felt in Escondido.
May 18, 1940	7.1, X - Strongly felt throughout S.D. County, some damage.	"Very distinct, but no damage" centered El Centro, Heavy damage in Imperial Valley Cities.
Dec 30-31 1934	Imperial Valley in Mexico - 7.1, IX, X, Strongly felt in S.D.	--------
Mar 10, 1933	Long Beach Quake - 6.25, IX. Aftershock felt in S.D.	First quake felt with severity, but no local damage reported. Many after shocks, strong enough to be felt locally, first caused people to run from houses.
May 15, 1910	Lake Elsinore, 6.0, Felt in S.D.	No local report.

*Pinckney C.J., McEuen, RB. "Seismic Risk in S.D.."Transactions of the S.D. Society of Natural History. Vol. 1F, No. 4. July 19, 1972.

DATE	LOCATION AND MAG. OR INTENSITY*	ESCONDIDO TIMES ADVOCATE COMMENTS
Dec 23, 1899	San Jacinto Fault, IX - felt in S.D.	-------
July 3, 1896	S.D. (Small)	
Oct 23, 1894	S.D. Poway, VII, minor damage	
Feb 23, 1892	Considerable damage in S.D.	
Feb 9, 1890	San Jacinto Fault, VI - felt in S.D.	
Mar 11, 30 & Oct 8, 1882	S.D. III - V	
Dec 21, 1880	V	
Apr 19, 1865	S.D. - Severe	
May 27 & June 13-14, 1862	May 27 - Severe at S.D., Temecula	
Sep 20, 1856	VII in S.D. County - cracked walls, ceilings fell, cattle stampeded at Santa Ysabel.	
Oct 26 & Nov 27-30, 1852	Nov. 29 = IX. Light quakes for several days	
Apr 12, 1852		
Sep 22, 1849		
Sep 16, 1849		
June 23, 1843	Very severe, S.D.	
Dec 8, 1812	VIII - IX. Strongly felt in S.D. destroyed Mission San Juan Capistrano	
Oct 12, 1812	Shocks for 40 days	
May 1812	Nearly continuous shocks for 4 1/2 months	
May 25, 1803	Slight damage S.D. Mission Church	
Nov 22, 1800	VII in So. Cal. damage to S.D. Presidio barracks	
Apr 11, 1769	Listed as severe in S.D. - diary of Miguel Costanso, Portola Expedition.	

SEISMIC HAZARDS

FAULTING, SURFACE RUPTURE

Surface ruptures usually occur on existing faults or fault traces, but may occur anywhere within a fault zone. A surface rupture occurs when a fault displacement extends upward from depths of epicenter and intersects the ground surface. The surface will not rupture every time a fault moves. As earthquakes increase in magnitude, there is a stronger possibility of ground rupture occurring. When the surface is ruptured, everything in its path will be affected.

GROUND SHAKING

As displacement occurs along a fault, the energy released creates a shock wave movement through the rock and soil materials of the earth's outer crust, radiating outward from the quake epicenter. This action is felt as a shaking motion at the ground surface. The severity of the ground shaking depends on the magnitude of the earthquake, the distance of the site from the quake epicenter, and soil conditions at the site and in between. Ground shaking can be felt and cause damage hundreds of miles from the epicenter of the earthquake. The effects of ground shaking on the works of man depend on its severity based on the above factors, and on the type of construction and its integrity.

Of particular importance in understanding the effects of shaking is the concept of "period". Tall buildings and thick, saturated sediments have longer predominate periods (natural vibration response) than short buildings and shallow sediments. Damage becomes greatest when the period of the building coincides with the period of the soil and bedrock. Although a short building of the same predominant period as the shallow sediments it rests on may be damaged during seismic event, the evidence suggests that the greatest seismic damage occurs to tall buildings on thick, relatively soft, saturated sediments. Because the period of vibration resulting from a seismic event will vary widely with size, distance, and direction of a quake, it is not feasible to project the exact period of foundation sediments. The presence of thick unconsolidated and saturated sediments suggests that long period (2 sec. or greater) vibration may occur during a seismic event. Soil and foundation conditions should be of the utmost importance in considering the

location of high rise structures.

During a seismic event, relatively long period vibration should be expected in the low lying areas underlain by thick sediments,with shorter period vibrations occurring in the hill and shallow bedrock areas. Considering the lack of high rise structures and the past performance of existing structures during seismic events, Escondido should sustain only light to moderate damage during maximum probably seismic events of the future.

GROUND FAILURE

Landslides are the down-hill movement of masses of earth material under the force of gravity. This movement can occur instantaneously or over a period of weeks or years, and can affect areas from less than 100 square feet to square miles.

Primary Causes of Landslides. There are a number of situations in which landslides are likely to occur. These situations include:

1. Areas where bedding or joint planes dip steeply and in the same direction as the slope.
2. Areas where thick saturated soils lie on steep slopes.

These conditions can be aggravated by improper grading or drainage practices. Removing soils from the toe or foot of the slope can remove support for the slope and increase the possibility of slippage. Improper or unplanned drainage can direct water into the soil, increasing the weight of the soil mass while lubricating the slippage planes. Landsliding can be triggered by gravity, soil saturation, seismic shaking, blasting, or even heavy vibrations caused by traffic or noise.

The most effective way to avoid landslides is to prevent development of landslide-prone areas. However, modern engineering practices, although costly, can stabilize most slide-prone areas through application of one or more techniques including but not limited to removing, redistribution, compacting or otherwise stabilizing hazardous earth masses, installing proper drainage devices, use of buttress fills, and careful landscaping and irrigation practices. No known landslides have occurred within the

present Escondido City limits. However, the San Diego County Map of landslides shows a landslide along the Valley Center Road approximately 3 miles past the Lake Wohlford turnoff, which is within the Escondido Planning Area. On February 24, 1969, this slide blocked the Valley Center Road. The slide was the result of localized instability aggrevated by a very steep, approximately 100 foot high road cut. Possible reactivation of the slide could temporarily block the Valley Center Road, however, there is a paved alternate road located just east of the main road.

The lack of landslide activity in Escondido is directly related to the well-drained and shallow soil profiles, the soil types present within the Planning Area, and the relatively limited development of steep slopes. As development pressures cause the development of steeper and less desireable building sites, the chances for landslides increase.

Through proper grading and construction techniques, along with the review of soils and/or geologic studies, the hazard from landslides can be minimized. The present procedure for reviewing grading appears sufficent to review possible unidentified localized landslide problems. A grading permit is required for grading cuts greater than 2' and more than 50 yds. in volume. If the slope is greater than 10% or conditions otherwise warrant, a site-specific soils or geology report may be required. Should unstable conditions be indicated the engineer may require appropriate mitigation or denial of the permits.

San Diego County has jurisdiction for grading permits for the area outside of the City limits but within the Escondido Planning Area. San Diego County grading review, although not as strict as Escondido's, appears to offer adequate review for the identification and mitigation of possible unidentified localized hazardous slopes. The County grading ordinance is also under study for possible changes related to hillside development.

LIQUEFACTION

Liquefaction is the loss of strength in granular, saturated, unconsolidated sediments. Areas with deep sediments and shallow water tables are particularly

susceptable to liquefaction. Damage from liquefaction may be caused as the ground liquefies and flows or lurches, or the ground may respond as quicksand causing buildings to tilt or sink. For liquefaction to occur, three factors must be present:

1. Soils must be loose, evenly graded fine sands or silts.
2. The water table must be shallow.
3. Intense, long duration ground shaking (greater than .13g with a duration of greater than 45 seconds) must occur.

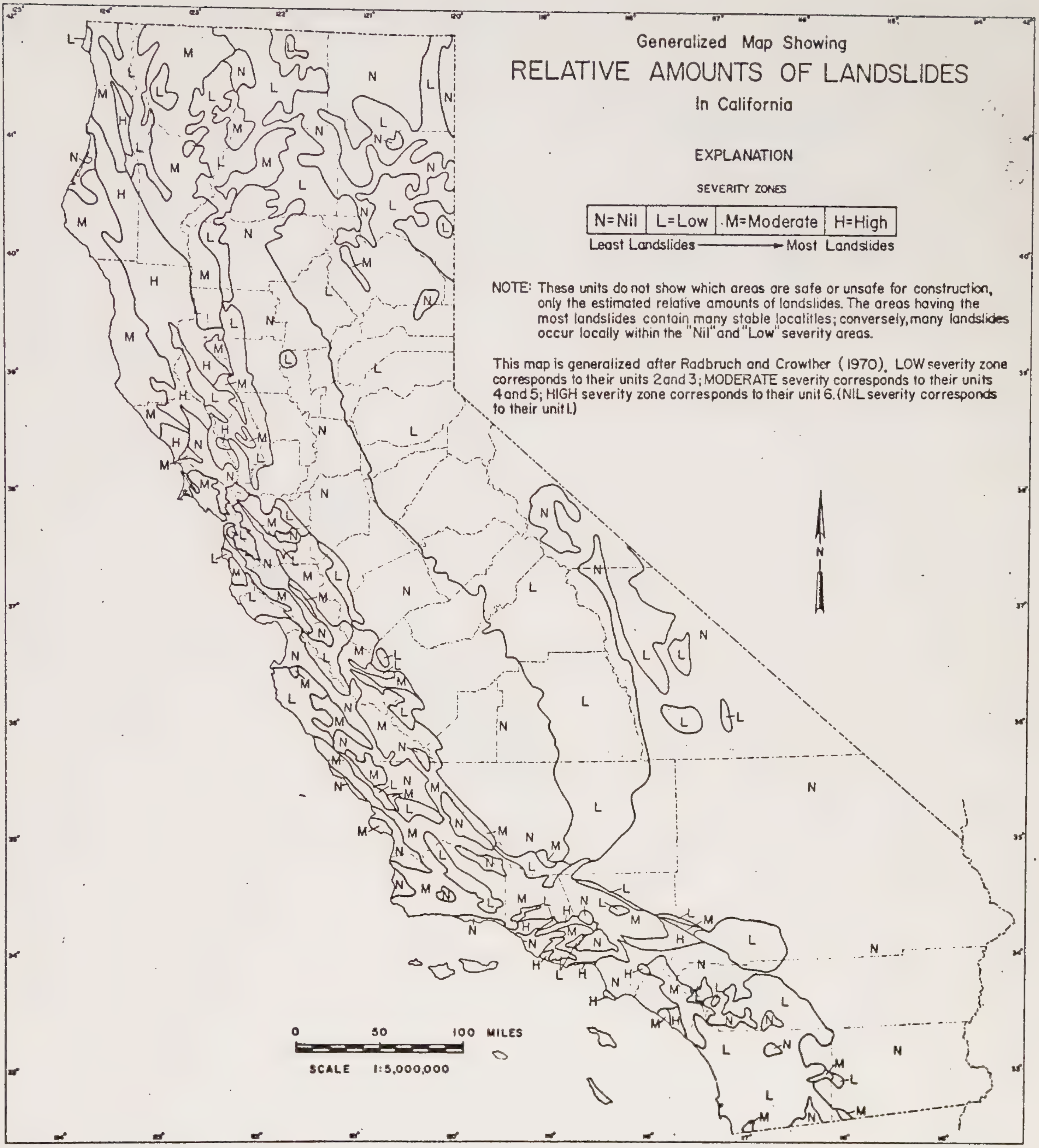
A preliminary investigation of soil conditions in the Escondido valley indicates that there is little or no potential for liquefaction. This conclusion is based primarily on the structure and particle size mix of the soil types found in the low lying areas of the Escondido valley. For liquefaction to occur, soils must be loose, evenly graded fine sands or silts. According to the U. S. Soil and Conservation Service Soil Survey for the San Diego Area, the soils of the low lying areas are sandy loams with clay substrata. The high percentage of clay particles intergraded with sands reduce interstical space and gives the soils a massive structure. The only exception to this is the Reiff fine sandy loam. This soil lacks the clay substratum of the other low lying soils, but its unevenly graded sands and silts also have a massive structure. This massive structure and intergrading of particle sizes reduces interstical space, giving soils a relatively high density and a low potential for compression or flowage during seismic activity.

Given these soil conditions and the lack of evidence of any past history of intense, long duration ground shaking as a result of nearby seismic activity, it is believed that the three factors necessary for liquefaction to occur are not present in the correct combination, and that as a result, the potential for liquefaction in the Escondido area apparently does not exist.

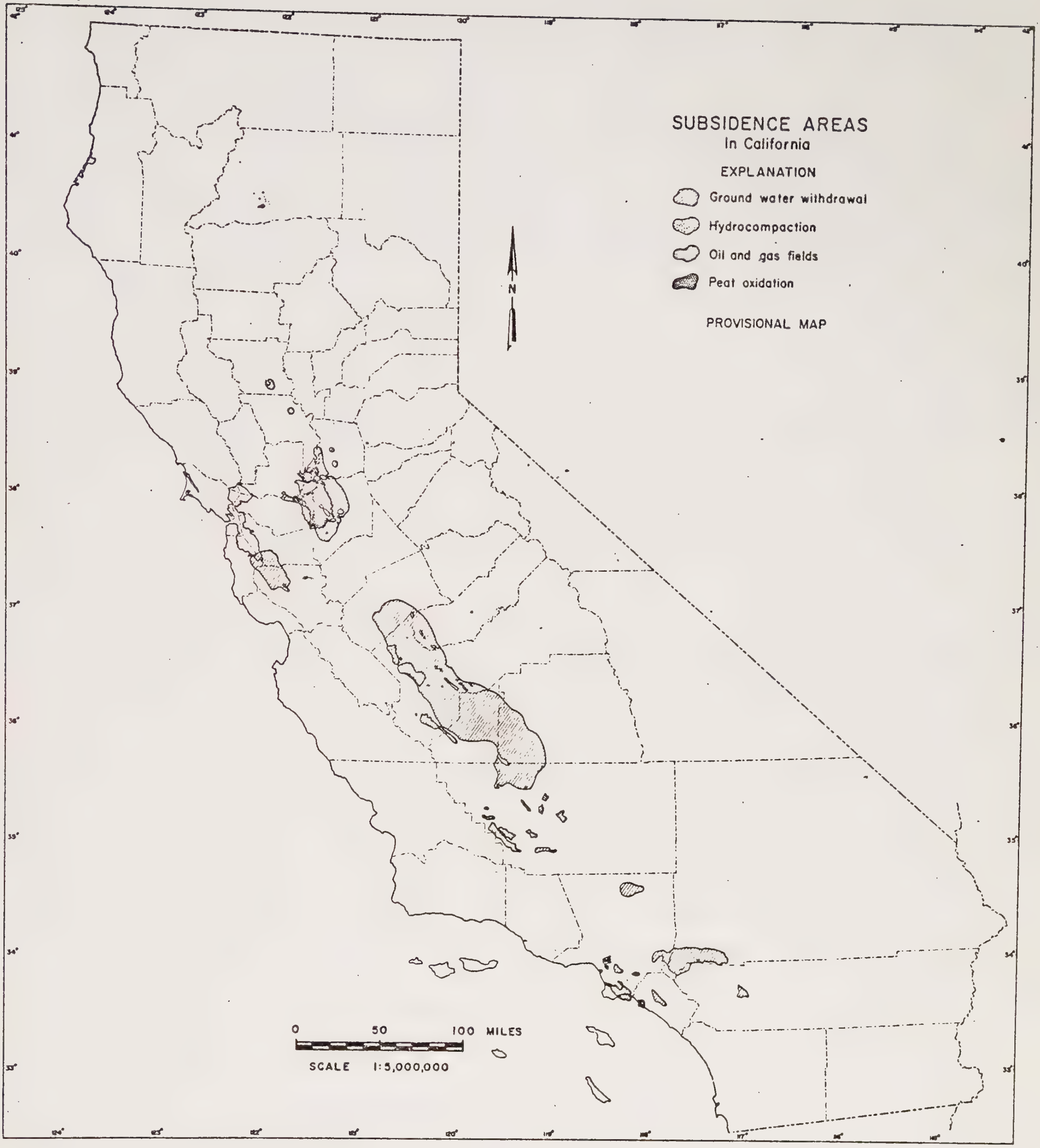
SUBSIDENCE

Subsidence is the downward settling of materials with little horizontal motion. There are four primary causes of subsidence:

1. Ground water withdrawal.
2. Oil or gas withdrawal.



Source:
California Division of Mines and Geology, Bulletin #198 1973.



Source:
California Division of Mines and Geology, Bulletin #198 1973.

3. Hydrocompaction; (usually caused by first time wetting of open textured soils which compact under their own weight).

4. Peat Oxidation (results from shrinkage of burial organic debries).

There have been no significant cases of subsidence in or around Escondido, and is not considered a problem in the San Diego County region, since the above conditions do not exist locally.

TECTONIC CREEP

Tectonic Creep is the very slow, continous movement along a fault. The range of movement is normally a small fraction of an inch a year. The movement occurs along a fault and is a hazard only if improvements are built directly over it. Since no active faults have been identified in the Planning Area, this problem is not a factor locally.

STRUCTURAL HAZARD

The large majority of buildings within the Escondido Planning Area have been constructed within the past thirty years. The Uniform Building Code has contained seismic design standards since 1943, although plan checking and inspection and the standards themselves have significantly improved since that time. Experience in recent earthquakes indicates that when structures are built according to seismic design standards they can be expected to perform well during an earthquake.

As a result of the "Unsafe Buildings Ordinance" (No. 1147, Feb. 1967), the Building Inspection Department conducted a survey of structures in the CBD. This survey was conducted with the aid of consulting structural engineers. Buildings considered unsafe were thoroughly inspected and compliance to fire and safety codes was required. Among the improvements required in the rehabilitation program were the removal of numerous second stories, addition and reinforcement of structural members, and interior and exterior reinforcement of unreinforced masonry. In all, 40 critical single-story structures and 18 critical two-story structures were either demolished or rehabilitated. Minor modifications and repairs were required on 116 non-conforming

structures in this area. Although many of these modifications were not related directly to seismic safety, they significantly reduced hazard from falling debris and widespread fire or explosion resulting from seismic events. Fire and explosion are frequently the greatest cause of damage in seismic events. The majority of structures in the Escondido area have been built since Uniform Building Code requirements were applied in 1933. Structures within Escondido built under the U.B.C. should receive little or no damage during maximum probable seismic events. There are an unknown number of structures built before the U.B.C. While many of these structures are substantially built, some, particularly unreinforced masonry, would be subject to moderate to heavy damage during major seismic events.

DAM HAZARD

In evaluating dam performance during a seismic event a number of factors must be considered:

1. Structural integrity of the dam with respect to projected seismic spectra.
2. Potential for landslides causing possible overtopping.
3. Potential for seiche causing overtopping.

The state office of Emergency Services is requiring dam owners to prepare inundation maps and disaster and evacuation plans. These studies will be completed in early 1976. However, at this point some preliminary statements about the safety of Escondido's dams can be made.

Dixon Dam is a rock and earth fill water storage facility approximately 850' long and 110' high with a capacity of 2,606 acre ft. Construction plans were approved May 12, 1967, and state safety certification for maximum capacity use was approved December 17, 1970. Throughout the engineering and safety review of the dam site no faults or landslides were identified. Very thin soil accumulations and a specially designed two-stage spillway make chances of overtopping from either landslide or seiche remote.

Wohlford Dam originally was a rockfill wooden-faced 76' high structure built in 1894. In 1923-24 the dam was rebuilt as a hydraulic fill structure incorporating the original structure and raising the dam to 100 feet. Several later renovations improved the spillway and added a sheet pile wall to the upper 20 feet of the dam. The California Office of Dam Safety on June 1, 1964 surveyed, inspected and certified the dam as in "apparently good condition", to satisfy the requirements of Federal Power Commission Order No. 315.

In 1969 the Escondido Mutual Water Company contracted with Dames and Moore, consulting engineers, for an evaluation of the safety of Lake Wohlford. This extensive report was followed by a second inspection and review 5 years later.
Both reports concluded:

1. No faults or landslides were identified in the vicinity of the Dam.
2. Design criteria for the Dam was sufficient for maximum probable seismic events expected from Elsinore, San Jacinto and San Andreas faults. (Maximum probable events used for this study were .4 (Richter Mag.) lower for the Elsinore Fault and .4 (Richter Mag.) higher for the San Jacinto than maximum probable events listed in this element).
3. The chances of overtopping from either run-off exceeding capacity of spillway or landslide seem remote.

The State Department of Water Resources, Division of Dam Safety, currently allows Lake Wohlford to retain only 4,019 acre ft. of water. The temporary reduction will remain in effect until a re-evaluation of the seismic stability of the dam under the new State standards, established after the 1971 San Fernando earthquake, is completed in 1976. Reduced dam capacity combined with the apparent safety of the dam make the possibility of catastrophic failure from either earthquake or seiche very remote.

RISK

CONCEPT OF RISK

Earthquakes are not yet predicitible with any accuracy. It is a fact that an earthquake will occur in certain areas sometime in the future. Geotechnical experts are beginning to be able to establish approximate rate of occurrance and possible magnitude of future quakes. In the past, earthquakes have caused significant damage and injury, especially in California. It is this knowledge of the past and the potential for future quakes that make the determination of acceptable risk important in future planning.

Risk is the chance of damage or injury occurring over some period of time. There is some risk involved in almost any human activity. The basic objective of evaluating seismic risk is to reduce the loss of life and property damage due to seismic activity to an "acceptable" level. It is not possible nor completely practical to eliminate all risk to life and property.

The Council of Intergovernmental Relations, (CIR) guidelines for the Seismic Safety Element of the General Plan defines acceptable risk as:

> "The level of risk below which no specific action by local government is deemed to be necessary other than making the risk known."

Because risk is a function of chance, there is an inherent degree of uncertainty in using risk as a basis for land use planning. However, when risk can be determined, programs incorporating the risk may be developed and compared to alternative programs. With this knowledge, risk-reduction measures can be enacted, and risk can be a framework for land use decision-making.

Every seismic hazard has an associated element of risk. This risk has two aspects: one is the chance that the hazard will in fact occur, and the other aspect is the chance that if the hazard does occur, the measures taken to mitigate the hazard will be sufficient to reduce the damage to life and property to a predetermined

acceptable level. There are no means with which to prevent an earthquake or its natural effects, but the potential for disaster can be minimized. Wise land use planning can reduce the hazard to life and property.

Factors which should be considered in establishing "acceptable" risk include:

1. Special importance of essential facilities during seismic events.
2. The number of persons subjected to hazardous conditions.
3. Voluntary or involuntary use.
4. Cost of eliminating potential risk.

Essential Facilities are those structures or buildings which must be safe and usable for emergency purposes after an earthquake in order to preserve peace, health and the safety of the public. Such facilities include but are not limited to:

1. Hospitals and other medical facilities having surgery or emergency treatment areas.
2. Fire and police stations.
3. Municipal government disaster operation and communication centers deemed vital in emergencies. These facilities are defined and listed on page 61 of the Emergency Plan for the City of Escondido.
4. Public Utility facilities.

Because the destruction of any of these facilities could compound problems or emergencies resulting from earthquakes, only a very low level of risk should be acceptable in the location and construction of these facilities.

Occupancy Levels: The number of persons using or occupying a structure should receive important consideration in determining acceptable risk. High occupancy uses such as large meeting halls, theatres, churches, office buildings and shopping centers could subject large numbers of persons to hazards. Only a low level of risk should be acceptable in high occupancy uses. A higher level of risk may be acceptable in low occupancy uses such as warehouses and single family houses. The concept of "Person to hours of occupancy" can be useful in determining priority in reducing risk.

Voluntary vs. Involuntary: Involuntary risk occurs in structures and uses where a person has no choice in whether to submit to a certain level of risk. These uses include schools, hospitals, mental hospitals, jails, convalescent homes. Because persons using these facilities may be incapable or restrained from leaving during an earthquake, only a very low level of risk should be acceptable.

Cost of Mitigation: Cost may be the most important factor in reducing risk. The reduction of risk must be balanced against the cost of achieving that reduction. These costs may be direct costs as in the case of reinforcing a building, or indirect as in the case of zoning seismically hazardous areas as open space. The following are examples of mitigation measures in which cost is an important factor in reducing risk.

1. Rehabilitation or demolition of non-conforming structures.
2. Requiring design of certain new buildings to meet extraordinary seismic design criteria.
3. Limiting or prohibiting development in hazardous areas.

Public Hearing to Establish Acceptable Levels of Risk: In planning the reduction of seismic hazards and achieving an acceptable level of risk it is important to involve public input through the public hearing process. The public hearing serves to identify potential hazards to the public, and to determine what costs the public believes reasonable in achieving acceptable risk.

The Planning Department would prepare, with the aid of the Building Inspection and Engineering Departments, a report of potential alternative programs for reducing seismic hazards. These programs should include specific proposals for reducing risk along with a discussion of costs and benefits achieved through possible implementation. Presenting these alternatives in a public hearing format would insure public input in determining both risk and costs to which they will be subjected. The findings of such hearings should be added to the seismic safety element.

Relationship to the Escondido Situation: This report has not identified any seismic-related risks that are not deemed adequately covered or mitigated by existing codes, ordinances, or practices. Therefore, there does not appear to be a need at this time to initiate public hearings for the purpose of evaluating acceptable levels of risk and methods of mitigation.

At the time that the required dam inundation studies are completed, it may be desirable to adopt mitigating measures via the public hearing process if hazards are identified. Also, since geologic and/or soil reports are required in certain cases and it is recommended these reports be filed in a central location, it is possible that as additional information becomes available, the need to alter present standards or practices may become apparent. At that point in time, the evaluation of risk via the public hearing process should be utilized.

APPENDIX A

California Council on Intergovernmental Relations - General Plan Guidelines

SEISMIC SAFETY ELEMENT

1. AUTHORITY

A. Authority

Government Code Section 65302(f) requires a seismic safety element of all city and county general plans, as follows:

> A seismic safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to the effects of seismically induced waves such as tsunamis and seiches.
>
> The seismic safety element shall also include an appraisal of mudslides, landslides, and slope stability as necessary geologic hazards such as possible surface ruptures from faulting, ground shaking, ground failure and seismically induced waves.

The effect of this section is to require cities and counties to take seismic hazards into account in their planning programs. All seismic hazards need to be considered, even though only ground and water effects are given as specific examples. The basic objective is to reduce loss of life, injuries, damage to property, and economic and social dislocations resulting from future earthquakes.

B. Background

Earthquake losses in California through the remainder of this century. assuming that additional significant counter-measures are not taken, have recently been estimated at approximately $20 billion (Urban Geology Master Plan, California Division of Mines and Geology). Estimates of potential loss of life for this period range well up into the thousands and most of this loss is preventable.

The most widespread effect of an earthquake is ground shaking. This is also usually (but not always) the greatest cause of damage. Structures of all types, including engineered structures and public utility facilities, if inadequately constructed or designed to withstand the shaking force, may suffer severe damage or collapse. The vast majority of deaths during earthquakes are the result of structural failure due to ground shaking. Most such deaths are preventable, even with present knowledge. New construction can and should be designed and built to withstand probable shaking without collapse. The greatest existing hazard in the State is the continued use of tens of thousands of older structures incapable of withstanding earthquake forces. Knowledge of earthquake-resistant design and construction has increased greatly in recent years, though much remains to be learned.

A second effect of earthquakes is ground failure in the form of landslides, rock falls, subsidence and other surface and near-surface ground movements. This is often the result of complete loss of strength of water-saturated sub-surface foundation soils ("liquefaction"), such as occurred near the Juvenile Hall in the 1971 San Fernando earthquake, and in the massive Turnagain Arm landslide in Anchorage, during the 1964 Alaska earthquake. Most such hazardous sites can be either avoided or stabilized if adequate geologic and soil investigations are utilized.

Another damaging effect of earthquakes is ground displacement (surface rupture) along faults. Such displacement of the earth's crust may be vertical, horizontal or both and may offset the ground by as much as 30 feet (as in 1857 in Southern California). It is not economically feasible to design and build foundations of structures (dams, buildings, bridges, etc.) to remain intact across such zones. Fault zones subject to displacement are best avoided in construction. In addition to regional

investigations necessary to the basic understanding of faults and their histories, detailed site investigations are needed prior to the approval of construction in any suspected active fault zone. Utilities, roads, canals and other linear futures are particularly vulnerable to damage as the result of ground displacement.

Other damaging effects of earthquakes include tsunamis (seismic sea waves, often called "tidal waves"), such as the one which struck Crescent City and other coastal areas in 1964; and seiches (waves in lakes and reservoirs due to tilting or displacement of the bottom or margin). The failure of dams due to shaking, fault displacement or overtopping (from seiches or massive landsliding into the reservoir) can be particularly disastrous. Most modern dams are designed and constructed to be earthquake-resistant; some older dams were not. In addition to man-made dams, temporary dams may be created by earthquake-triggered landslides. Such inadvertently created dams are certain to fail within a relatively short time.

2. THE SCOPE AND NATURE OF THE SEISMIC SAFETY ELEMENT

A. A general policy statement that:

1. Recognizes seismic hazards and their possible effects on the community.
2. Identifies general goals for reducing seismic risk.
3. Specifies the level or nature of acceptable risk to life and property (see safety element guidelines for the concept of "acceptable risk").
4. Specifies seismic safety objectives for land use.
5. Specifies objectives for reducing seismic hazard as related to existing and new structures.

B. Identification, delineation and evaluation of natural seismic hazards.

C. Consideration of existing structural hazards.

Generally, existing substandard structures of all kinds (including substandard dams and public utility facilities) pose the greatest hazard to a community.

D. Evaluation of disaster planning program:

For near-term earthquakes, the most immediately useful thing that a community can do is to plan and prepare to respond to and recover from an earthquake as quickly and effectively as possible, given the existing condition of the area. The seismic safety element can provide guidance in disaster planning.

E. Determination of specific land use standards related to level of hazard and risk.

3. METHODOLOGY

As an initial step, it may be helpful to determine what aspects of the element need greater emphasis. If a community is largely developed, emphasis on structural hazards and disaster planning would be most appropriate. This would also be the case for communities whose greatest hazard will be from ground shaking. On the other hand, communities with extensive open areas and areas subject to urbanization may wish to focus on natural seismic hazards and the formulation of land use policies and development regulations to insure that new development is not hazardous.

Additionally, local planning agencies may wish to consider the preparation of the element or portions of the element in joint action. This would be particularly practical for the study of natural seismic hazards.

A. Initial organization

(1) Focus on formulating and adopting interim policy based on very general evaluation of earth science information readily available.

(2) Evaluate adequacy of existing information in relation to the identified range and severity of problems.

(3) Define specific nature and magnitude of work program needed to complete the element in a second stage.

B. Identification of natural seismic hazards.

(1) General structural geology and geologic history.

(2) Location of all active or potentially active faults, with evaluation regarding past displacement and probability of future movement.

(3) Evaluation of slope stability, soils subject to liquefaction and differential subsidence.

(4) Assessment of potential for the occurrence and severity of damaging ground shaking and amplifying effects of unconsolidated materials.

(5) Identification of areas subject to seiches and tsunamis.

(6) Maps identifying location of the above characteristics.

C. Identification and evaluation of present land use and circulation patterns should be recognized in the formulation of seismic safety-land use policies.

D. Identification and evaluation of structural hazards relating structural characteristics, type of occupancy and geologic characteristics in order to formulate policies and programs to reduce structural hazard.

E. Formulation of seismic safety policies and recommendations.

F. Formulation of an implementation program.

4. DEFINITION OF TERMS

A. Acceptable risk: The level of risk below which no specific action by local government is deemed necessary, other than making the risk known.

Unacceptable risk: Level of risk above which specific action by government is deemed necessary to protect life and property.

Avoidable risk: Risk not necessary to take because the individual or public goals can be achieved at the same or less total "cost by other means without taking the risk."

B. Technical Terminology:

Tsunamis: Earthquake-induced ocean waves, commonly referred to as tidal waves

Seiches: Earthquake-induced waves in lakes or ponds.

Seismic: Pertaining to or caused by earthquake.

Soil Liquefaction: Change of water saturated cohesionless soil to liquid usually from intense ground shaking; soil loses all strength.

Tectonic, forms, forces, and movements resulting from deformation of the earth's crust: Movement may be rapid resulting in earthquake, or slow (tectonic creep).

Fault: A plane or surface in earth materials along which failure has occurred and materials on opposite sides have moved relative to one another in response to the accumulation of stress in the rocks.

Active Fault: A fault that has moved in recent geologic time and which is likely to move again in the relatively near future. (For geologic purposes, there are no precise limits to recency of movement or probable future movement that define an "active fault". Definitions for Planning purposes extend on the order of 10,000 years or more back and 100 years or more forward. The exact time limits for planning purposes are usually defined in relation to contemplated uses and structures.)

Inactive Fualt: A fault which shows no evidence of movement in recent geologic time and no evidence of potential movement in the relatively near future.

Seismic Hazards: Hazards related to seismic or earthquake activity.

Ground Failures: Include mudslide, landslide, liquefaction, subsidence.

Surface ruptures from faulting: Breaks in the ground surface resulting from fault movement.

5. RELATIONSHIPS

A. To Other Elements:

The Seismic Safety Element contributes information on the comparative safety of using lands for various purposes, types of structures, and occupancies. It provides primary policy inputs to the land use, housing,

open space, circulation and safety elements.

Because of the close relationship with the safety element the local planning agency may wish to prepare these two elements simultaneously or combine the two elements into a single document. If combined, the required content and policies of each element should be clearly identifiable. The local jurisdiction may wish to include the Seismic Safety Element as part of an environmental resources management element -ERME - as discussed previously.

B. To Environmental Factors:

(1) Physical: Geologic hazards can be a prime determinant of land use capability.

(2) Social: May provide basis of evaluating costs of social disruptions, including the possible loss of life due to earthquake and identifies means of mitigating social impact.

(3) Economic: Cost and benefits of using or not using various areas related to potential damage or cost of overcoming hazard.

(4) Environmental Impact Report: Provides basis for evaluating environmental impact of proposed projects in relation to slope stability,possible structure failure, etc.

C. To Other Agencies:

The State Geologist is required by Chapter 7.5, Division 2 of the Public Resources Code to delineate by December 31, 1973, special studies zones encompassing certain areas of earthquake hazard on maps and to submit such maps to affected cities, counties, and state agencies for review and comments.

By December 31, 1973, the Division of Mines and Geology will have delineated the special studies zones encompassing all potentially and recently active traces

of the San Andreas, Calaveras, Hayward, and San Jacinto Faults. The special studies zones will be delineated on U.S. Geological Survey quadrangle sheets. The quadrangles listed in Appendix F will be included in the initial distribution which will begin on or about October 1, 1973, and be completed by December 31, 1973. In addition to the faults named above, all active or potentially active faults within the quadrangles listed will be zoned. The zones are ordinarily about one-quarter mile in width.

The State Mining and Geology Board is required by Chapter 7.3, Division 2 of the Public Resources Code to develop policies and criteria by December 31, 1973, concerning real estate developments or structures to be built within the special studies zones.

6. IMPLEMENTATION

A. Concurrent or subsequent revision of other general plan elements to give specific recognition to seismic safety policies and criteria.

B. Inclusion of appropriate requirements and procedures in zoning, subdivision and site development regulations and building codes. Designation of "seismic hazards management zones".

C. Preparation of renewal plans for areas where a change in use and development pattern is necessary because of major seismic damage or extreme hazard.

D. Building inspection program to identify unsafe structures and instigate necessary corrective measures.

E. Inclusion of potential earthquake destruction in contingency plans for major disasters and emergencies. Review and liaison with Emergency Preparedness Organizations and Police Departments of overall plans and major public facilities proposals as to their adequacy in emergency situations.

F. Educational programs to develop community awareness of seismic hazards.

G. Updating the building code to reflect changes in technology.

NOTE: These guidelines drew extensively from:

Suggested Interim Guidelines for the Seismic Safety Element in General Plans, prepared by the Governor's Earthquake Council, July, 1972.

Draft Guidelines for the Seismic Safety Element, prepared by Advisory Group on Land Use Planning for Joint Committee on Seismic Safety, California State Legislature, September, 1972.

Seismic Safety Concerns in CIR/OIM Program prepared for CIR by William Spangle & Associates, March 1972, unpublished.

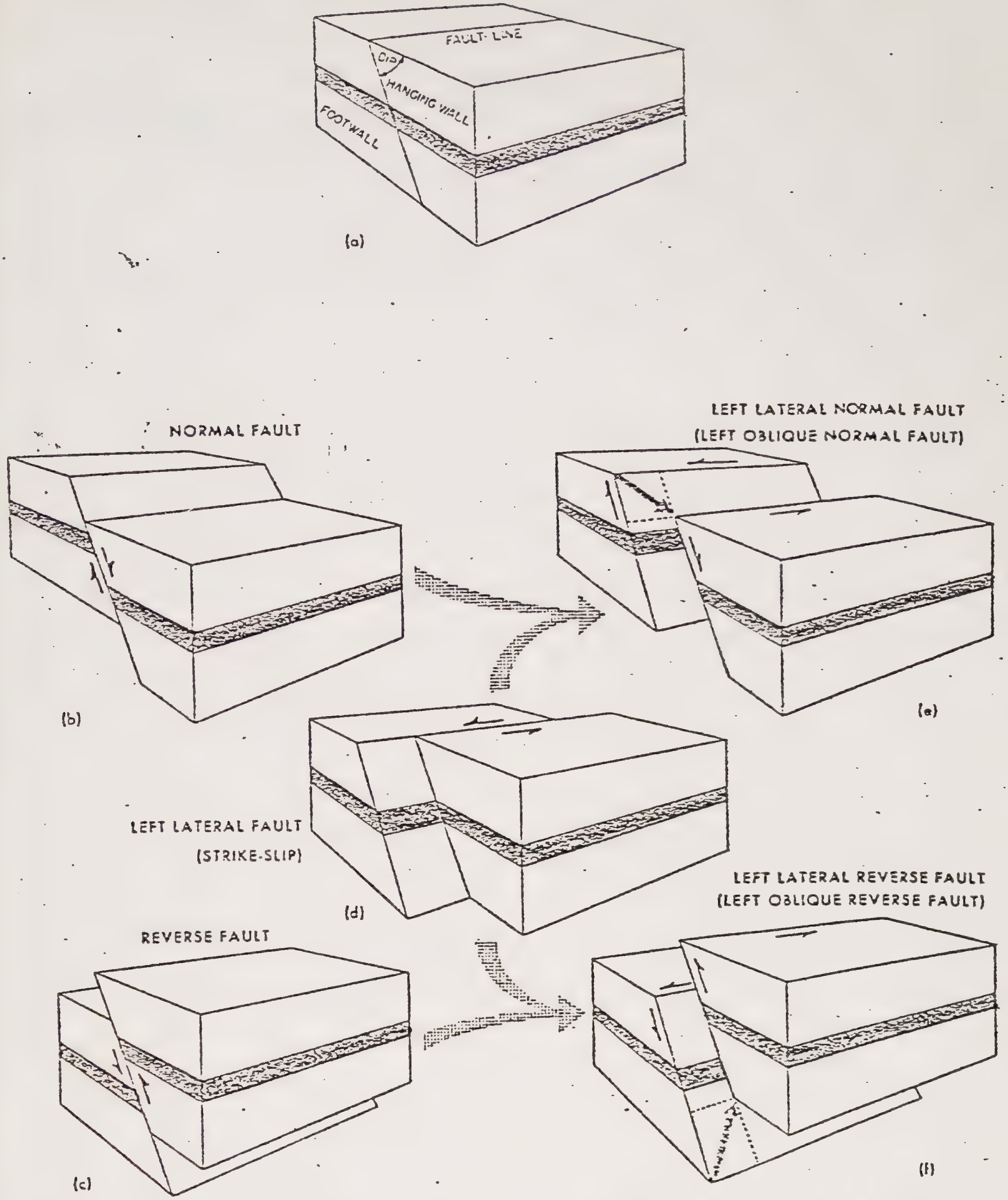
APPENDIX B

TYPES OF FAULTS

A fault is a plane of breakage in rock or soil along which significant offsetting of the two sides of the plane has taken place due to tectonic forces. Faults are described by their traits as being either active or inactive and based on relative movements.

Active faults are those that have experienced displacement in recent geologic time, and future displacement can be expected along these same faults. Inactive faults indicate no evidence of displacement in recent geologic time and are considered dormant.

Faults are also described based on relative movement of the planes. A normal fault is one where the hanging wall has moved down relative to the footing wall. A reverse fault or thrust fault is where the hanging wall has moved up relative to the footing wall. A lateral fault or strike-slip fault occurs as the rocks on either side of the fault have moved laterally past each other. Fault movements are almost always a combination of movement up/down and lateral.



Types of fault movement. a) Names of some of the components of faults. b) Normal fault, in which the hanging wall has moved down relative to the foot wall. c) Reverse fault, sometimes called thrust fault, in which the hanging wall has moved up relative to the foot wall. d) Lateral fault, sometimes called strike-slip fault, in which the rocks on either side of the fault have moved sideways past each other. It is called *left* lateral if the rocks on the other side of the fault have moved to the left, as observed while facing the fault and *right* lateral if the rocks on the other side of the fault have moved to the right, as observed while facing the fault. e) Left lateral normal fault, sometimes called a left oblique normal fault. Movement of this type of fault is a combination of normal faulting and left lateral faulting. f) Left lateral reverse fault, sometimes called a left oblique reverse fault. Movement of this type is a combination of left lateral faulting and reverse faulting. Two types of faults not shown are similar to those shown in e and f. They are a *right* lateral normal fault and a *right* lateral reverse fault (a right oblique normal fault and a right oblique reverse fault, respectively).

APPENDIX C

MEASURING SEISMIC ACTIVITY

There are two commonly used scales to measure seismic activity: the Richter Scale, and the Modified Mercalli Scale. The Richter Scale is based on instrument records, and measures earthquakes in terms of energy or magnitude. The Mercalli Scale is based on pérsonal observation and measures actual effects or intensity on a subjective basis.

The Richter Magnitude Scale measures the earthquake at the epicenter or source. It is an index of potential energy and the most commonly quoted rating in news reports and conversations. The scale is a logarithmic scale and this is commonly misunderstood. An earthquake having a Richter Scale rating of 8.5 is 10,000 times, not twice, the magnitude of a quake having a rating of 4.5 Also, due to the way the scale is tructured, a rating of 8.5 would represent 1,000,000 times as much energy as a rating of 4.5.

The modified Mercalli Intensity Scale is the most meaningful to the layman because it is based on observations at specific points. One earthwuake can and does have several intensities throughout the affected area. Generally, intensity would be highest nearest the spicenter and would decrease with distance, depending on soil and geologic conditions. This scale is the most useful for planning purposes.

Of the thousands of earthquakes felt during the past two hundred years, at least 3 -- Fort Tejon 1857, Owens Valley 1872, and San Francisco 1906 -- were truly "great" earthquakes (Richter magnitude greater than 7.7); at least twelve -- like Arvin-Tehachapi 1952, and El Centro 1940 -- were "major" earthquakes (magnitude 7.0 to 7.7); and over 60, such as Borrego Mountain 1968, Long Beach 1933 and San Fernando 1971, were "moderate" shocks (magnitude 6.0 to 6.9). In addition about 2000 earthquakes per decade in the magnitude range 4.0 to 5.9 have been

strongly felt in the Southern California area. According to the Joint Committee on Seismic Safety of the State legislation "California should anticipate a "great" earthquake every 60 to 100 years, a "major" earthquake on an average of about every 20 years, and "moderate" earthquake on an average of about every 20 years, and "moderate" earthquakes on an average of perhaps every 8 to 10 years."

THE MERCALLI INTENSITY SCALE

(As modified by Charles F. Richter in 1956 and rearranged)

If most of these effects are observed	Then the intensity is:
Earthquake shaking not felt, But people may observe marginal effects of large distance earthquakes without identifying these effects as earthquake-caused. Among them: trees, structures, liquids, bodies of water sway slowly, or doors swing slowly.	I
<u>Effect on people:</u> Shaking felt by those at rest, especially if they are indoors, and by those on upper floors.	II
<u>Effect on people:</u> Felt by most people indoors. Some can estimate duration of shaking. But many may not recognize shaking of building as caused by an earthquake; the shaking is like that caused by the passing of light trucks.	III
<u>Other effects:</u> Hanging objects swing. <u>Structural effects:</u> Windows or doors rattle. Wooden walls and frames creak.	IV
<u>Effect on people:</u> Felt by everyone indoors. Many estimate duration of shaking. But they still may not recognize it as caused by an earthquake. The shaking is like that caused by the passing of heavy trucks, though sometimes, instead, people may feel the sensation of a jolt, as if a heavy ball had struck the walls. <u>Other effects:</u> Hanging objects swing. Standing autos rock. Crockery clashes, dishes rattle or glasses clink. <u>Structural effects:</u> Doors close, open or swing, Windows rattle.	V
<u>Effect on people:</u> Felt by everyone indoors and by most people outdoors. Many now estimate not only the duration of shaking but also its direction and have no doubt as to its cause. Sleepers waken. <u>Other effects:</u> Hanging objects swing. Shutters or pictures move. Pendulum clocks stop, start or change rate. Standing autos rock. Crockery clashes, dishes rattle or glasses clink. Liquids disturbed, some spilled. Small unstable objects displaced or upset. <u>Structural effects:</u> Weak plaster and Masonry D* crack. Windows break. Doors close, open, or swing.	VI
<u>Effect on people:</u> Felt by everyone. Many are frightened and run outdoors. People walk unsteadily. <u>Other effects:</u> Small church or school bells ring. Pictures thrown off walls, knicknacks and books off shelves. Dishes or glasses broken. Furniture moved or overturned. Trees, bushes shaken visibly, or heard to rustle. <u>Structural effects:</u> Masonry D*damaged; some cracks in Masonry C* Weak chimneys break off at roof line. Plaster, loose bricks, stones, tiles, cornices, unbraced parapets and architectural ornaments fall. Concrete irrigation ditches damaged.	VII
<u>Effect on people:</u> Difficult to stand. Shaking noticed by auto drivers. <u>Other effects:</u> Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Furniture broken. Hanging objects quiver. <u>Structural effects:</u> Masonry D*heavily damaged; Masonry C*damaged, partially collapses in some cases; some damage to Masonry B*; none to Masonry A* Stucco and some masonry walls fall. Chimneys, factory stacks, monuments, towers, elevated tanks twist or fall. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off.	VIII
<u>Effect on people:</u> General fright. People thrown to ground. <u>Other effects:</u> Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes. Steering of autos affected. Branches broken from trees. <u>Structural effects:</u> Masonry D*destroyed; Masonry C*heavily damaged, sometimes with complete collapse; Masonry B*is seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frames racked. Reservoirs seriously damaged. Underground pipes broken.	IX
<u>Effect on people:</u> General panic. <u>Other effects:</u> Conspicuous cracks in ground. In areas of soft ground, sand is ejected through holes and piles up into a small crater, and, in muddy areas, water fountains are formed. <u>Structural effects:</u> Most masonry and frame structures destroyed along with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes and embankments. Railroads bent slightly.	X
<u>Effect on people:</u> General panic. <u>Other effects:</u> Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. <u>Structural effects:</u> General destruction of buildings. Underground pipelines completely out of service. Railroads bent greatly.	XI
<u>Effect on people:</u> General panic. <u>Other effects:</u> Same as for Intensity X. <u>Structural effects:</u> Damage nearly total, the ultimate catastrophe. <u>Other effects:</u> Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.	XII

*Masonry A: Good workmanship and morter, reinforced, designed to risist lateral forces.
Masonry B: Good workmanship and mortar, reinforced.
Masonry C: Good workmanship and mortar, unreinforced.
Masonry D: Poor workmanship and mortar and weak materials, like adobe.

COMPARISON OF SEISMIC MAGNITUDE AND INTENSITY SCALES

Richter Magnitude Scale	Equivalent Energy	Modified Mercalli Intensity Scale	Ground Acceleration In G's
1.0	6 oz TNT		
2.0	13 lbs TNT	I	
3.0	397 lbs TNT	II	
3.5	1,990 lbs TNT	III	.005
4.0	6 Tons TNT	IV	.01
5.0	199 Tons TNT	V	.05
5.5	1,000 Tons TNT	VI	
6.0	6,270 Tons TNT	VII	.1
6.5	31,550 Tons TNT	VIII	
7.0	199,000 Tons TNT	IX	.5
7.5	1,000,000 Tons TNT		1.0
8.0	6,270,000 Tons TNT	X	
8.5	31,550,000 Tons TNT		
9.0	199,000,000 Tons TNT		

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